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RADIO TEST REPORT – 450245 APFWL

Type of assessment:

MPE Calculation report

Applicant:

FLIR Unmanned Aerial Systems ULC

Product:

Ranger R Series Radar 9GHz band

Model:

Ranger® R8SS

Model Variant:

Ranger® R8SS-3D/U

FCC ID:

2AEYU-R8

Specifications:

- FCC 47 CFR Part 1 Subpart I, §§1.1307, 1.1310
- FCC 47 CFR Part 2 Subpart J, §2.1091
- FCC KDB 447498 D01 General RF Exposure Guidance v06

Date of issue: March 21, 2022

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	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1 Evaluation summary

1.1 MPE calculation for standalone transmission

1.1.1 References, definitions and limits

FCC §2.1091(d)

(2) (2) For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b) of this part, except for portable devices as defined in §2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in §2.1093.

Table 1.1-1: *Table 1 to §1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)*

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*(100)	≤6
3.0–30	1842 / f	4.89 / f	*(900 / f^2)	<6
30–300	61.4	0.163	1.0	<6
300–1500			f / 300	<6
1500–100000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	<30
1.34–30	824 / f	2.19 / f	*(180 / f^2)	<30
30–300	27.5	0.073	0.2	<30
300–1500			f / 1500	<30
1500–100000			1.0	<30

Notes: f = frequency in MHz. * = Plane-wave equivalent power density.

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (mW/cm^2 or W/m^2)
P = power input to the antenna (mW or W)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (cm or m)

1.1.2 EUT technical information

<table>
<tr><td>Prediction frequency</td><td>9500 MHz</td></tr>
<tr><td>Antenna type</td><td>Radar antenna</td></tr>
<tr><td>Antenna gain</td><td>9 dBi for R8SS-3D/U; 17.5 dBi for R8SS</td></tr>
<tr><td>Number of antennas</td><td>1</td></tr>
<tr><td>Maximum transmitter conducted power</td><td>45/39/33 dBm (25/8/2 W)</td></tr>
<tr><td>Prediction distance</td><td>As table below
<table>
<tr><td></td><td colspan="2">R8SS (25W)</td><td colspan="2">R8SS (8W)</td><td colspan="2">R8SS (2W)</td></tr>
<tr><td></td><td>Uncontrolled</td><td>Controlled</td><td>Uncontrolled</td><td>Controlled</td><td>Uncontrolled</td><td>Controlled</td></tr>
<tr><td>Prediction distance(cm):</td><td>400</td><td>180</td><td>200</td><td>90</td><td>100</td><td>50</td></tr>
</table>
<table>
<tr><td></td><td colspan="2">R8SS-3D/U (25W)</td><td colspan="2">R8SS-3D/U (8W)</td><td colspan="2">R8SS-3D/U (2W)</td></tr>
<tr><td></td><td>Uncontrolled</td><td>Controlled</td><td>Uncontrolled</td><td>Controlled</td><td>Uncontrolled</td><td>Controlled</td></tr>
<tr><td>Prediction distance(cm):</td><td>180</td><td>80</td><td>80</td><td>40</td><td>45</td><td>25</td></tr>
</table></td></tr>
</table>

1.1.3 MPE calculation

1. For R8SS, uncontrolled exposure, 25W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	45.24	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	45.24	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	33419.504	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	387	cm
Typical (declared) distance:	400	cm
Average power density at prediction frequency:	**0.934696**	**mW/cm^2**
	9.34696	W/m^2
Margin of Compliance:	**0.29330**	**dB**
Maximum allowable antenna gain:	17.79330	dBi

2. For R8SS, controlled exposure, 25W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	45.24	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	45.24	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	33419.504	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	173	cm
Typical (declared) distance:	180	cm
Average power density at prediction frequency:	**4.615780**	**mW/cm^2**
	46.15780	W/m^2
Margin of Compliance:	**0.34725**	**dB**
Maximum allowable antenna gain:	17.84725	dBi

3. For R8SS, uncontrolled exposure, 8W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	39.03	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	39.03	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	7998.343	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	189	cm
Typical (declared) distance:	200	cm
Average power density at prediction frequency:	**0.894809**	**mW/cm^2**
	8.94809	W/m^2
Margin of Compliance:	**0.48270**	**dB**
Maximum allowable antenna gain:	17.98270	dBi

4. For R8SS, controlled exposure, 8W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	39.03	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	39.03	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	7998.343	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	85	cm
Typical (declared) distance:	90	cm
Average power density at prediction frequency:	**4.418808**	**mW/cm^2**
	44.18808	W/m^2
Margin of Compliance:	**0.53665**	**dB**
Maximum allowable antenna gain:	18.03665	dBi

5. For R8SS, uncontrolled exposure, 2W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	33.01	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	33.01	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	1999.862	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	95	cm
Typical (declared) distance:	100	cm
Average power density at prediction frequency:	**0.894932**	**mW/cm^2**
	8.94932	W/m^2
Margin of Compliance:	**0.48210**	**dB**
Maximum allowable antenna gain:	17.98210	dBi

6. For R8SS, controlled exposure, 2W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	33.01	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	33.01	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	1999.862	mW
Single Antenna gain (typical):	17.5	dBi
Number of antennae:	1	
Total system gain (typical):	17.500	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	42	cm
Typical (declared) distance:	50	cm
Average power density at prediction frequency:	**3.579729**	**mW/cm^2**
	35.79729	W/m^2
Margin of Compliance:	**1.45120**	**dB**
Maximum allowable antenna gain:	18.95120	dBi

7. For R8SS-3D/U, uncontrolled exposure, 25W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	45.24	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	45.24	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	33419.504	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	145	cm
Typical (declared) distance:	180	cm
Average power density at prediction frequency:	**0.651996**	**mW/cm^2**
	6.51996	W/m^2
Margin of Compliance:	**1.85755**	**dB**
Maximum allowable antenna gain:	10.85755	dBi

8. For R8SS-3D/U, controlled exposure, 25W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	45.24	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	45.24	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	33419.504	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	65	cm
Typical (declared) distance:	80	cm
Average power density at prediction frequency:	**3.300731**	**mW/cm^2**
	33.00731	W/m^2
Margin of Compliance:	**1.80360**	**dB**
Maximum allowable antenna gain:	10.80360	dBi

9. For R8SS-3D/U, uncontrolled exposure, 8W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	39.03	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	39.03	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	7998.343	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	71	cm
Typical (declared) distance:	80	cm
Average power density at prediction frequency:	**0.789969**	**mW/cm^2**
	7.89969	W/m^2
Margin of Compliance:	**1.02390**	**dB**
Maximum allowable antenna gain:	10.02390	dBi

10. For R8SS-3D/U, controlled exposure, 8W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	39.03	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	39.03	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	7998.343	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	32	cm
Typical (declared) distance:	40	cm
Average power density at prediction frequency:	**3.159877**	**mW/cm^2**
	31.59877	W/m^2
Margin of Compliance:	**1.99300**	**dB**
Maximum allowable antenna gain:	10.99300	dBi

11. For R8SS-3D/U, uncontrolled exposure, 2W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	33.01	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	33.01	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	1999.862	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	1	mW/cm^2
	10	W/m^2
Minimum calculated prediction distance for compliance:	36	cm
Typical (declared) distance:	45	cm
Average power density at prediction frequency:	**0.624259**	**mW/cm^2**
	6.24259	W/m^2
Margin of Compliance:	**2.04635**	**dB**
Maximum allowable antenna gain:	11.04635	dBi

12. For R8SS-3D/U, controlled exposure, 2W operation

Fundamental transmit (prediction) frequency:	9500	MHz
Maximum measured conducted peak output power:	33.01	dBm
Cable and/or jumper loss:	0.0	dB
Maximum peak power at antenna input terminal:	33.01	dBm
Tx On time:	100.000	ms
Tx period time:	100.000	ms
Average factor:	100	%
Maximum calculated average power at antenna input terminal:	1999.862	mW
Single Antenna gain (typical):	9	dBi
Number of antennae:	1	
Total system gain (typical):	9.000	dBi
MPE limit for uncontrolled exposure at prediction frequency:	5	mW/cm^2
	50	W/m^2
Minimum calculated prediction distance for compliance:	16	cm
Typical (declared) distance:	25	cm
Average power density at prediction frequency:	**2.022601**	**mW/cm^2**
	20.22601	W/m^2
Margin of Compliance:	**3.93060**	**dB**
Maximum allowable antenna gain:	12.93060	dBi

1.1.4 Verdict

The calculation is below the limit; therefore, the product is passing the RF Exposure requirements for the declared distance.

End of the test report